Climate Change Fuel Cell Program

Cape Cod Community College

Final Report

Report on First Thirty Three Months Operating Experience
From April 1999 to December 2001

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Disclaimer:

ABSTRACT

Cape Cod Community College (CCCC) is in West Barnstable, Massachusetts. It is a nine building campus comprising approximately 300,000 total square feet. The complex opened in 1970 and was originally designed to be heated exclusively by electricity.

In 1997, NORESCO was selected to provide energy conservation services to CCCC to reduce energy costs at the facility. In April 1999, NORESCO completed construction of the project, which included electric to gas heat conversions, lighting upgrades, motor replacements and installation of variable frequency drives on air handler fans. In addition, a 200kW phosphoric acid PC25TM fuel cell power plant was installed near the campus library. In combination, the conservation measures reduced electricity consumption on campus by nearly 25 percent. The fuel cell operates continuously, producing 200 kW of base load electricity for the college. Thermal energy produced by the fuel cell is used for space heating in the 40,000 square foot library building.

A glycol mixture is piped from the fuel cell heat exchanger into the adjacent library mechanical room. Four air handling units in the mechanical space provide the library with either heating or cooling seasonally via a two pipe, combination heating/cooling coil. Hot water from the fuel cell is piped into the return side of the existing boiler, offsetting much of the heat load of the building. To increase usage of fuel cell thermal output, six electric reheat coils in the mechanical room were also converted to hot water.

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EXECUTIVE SUMMARY

A 200kW fuel cell has been installed at Cape Cod Community College in West Barnstable, Massachusetts. The college was looking to use the fuel cell to reduce their electrical consumption from their local utility. They were also interested in this project for it's positive environmental impact. The fuel cell results in reduced emissions as it produces electricity for the campus.

While the initial cost of the fuel cell system is more expensive than the alternatives, it provides the better long-term solution from a life cycle costing analysis. The constant use of the fuel cell allows the college to offset their electrical usage from the utility grid during peak hours, and nearly eliminates their use of the electric grid at off-peak times.

INTRODUCTION

The fuel cell at Cape Cod Community College was brought on line in April of 1999 and has run almost continuously since that time. The unit's output was 125 kW for the first month, but has run at 200kW since then. It has run reliably for over three years, being shut down mostly by power quality issues from the utility grid that it is tied into. The fuel cell enters a protective shut down mode due to voltage fluctuations and short-term outages. After these events, the unit must be manually restarted by an operator.

Due to these power quality issues, the maximum operating time between interruptions has been 2,660 hours. Overall, the unit has been operating well over 90% of the time, even after accounting for the outside problems.

RESULTS AND CONCLUSIONS

MEAN TIME BETWEEN FAILURE AND RELIABILITY
Individual Fuel Cell Operation
Fuel Cell Serial Number 9098

During the first thirty three months of operation the longest continuous run for fuel cell SN9098 was 2,660 hours.

For the period from April 9, 1999 through December 31, 2001 (33 months) fuel cell SN9098 operated for 22,327 hours and delivered 4,086 MWhrs of electricity. For this period the availability was 93.22%. The mean time between forced outages was 971 hours. Figure 1 on the next page shows a graph of the kW produced over the first 22,000 hours of operation.

NATURAL GAS USAGE

In the first thirty three months of operation the fuel cells used 41,004 Mcf of natural gas. This is approximately 1243 Mcf per month. For the first month of operation the fuel cell was operated at 125 kilowatts, but was increased to 200 kilowatts ever since then.

THERMAL OUTPUT

Heat recovered from the fuel cell is shown by month in figure 2, expressed in MBTU (thousands of British Thermal Units). Thermal energy recovery is somewhat limited in this application because the heat is used to offset electric space heating, which only occurs in the colder months. It should also be noted that the data shown was taken more recently than the reporting period. The Energy Management System (EMS) on site is used to record the data, and this recent data is more reliable than data from previous periods. The drop in output during February appears to have occurred due to a vacation period, and variations in the reporting period during the early months of 2002. Heat is excess of that recovered to the hot water loop (and all thermal energy during the non-heating months) is rejected to atmosphere by means of a dry-cooler located next to the fuel cell.

CERTIFICATION

NORESCO certifies that it has complied in all respects with the grant under DE-FG21-96MC33347, Climate Change Fuel Cell Program and that the related efforts required by that grant are now fully complete including twelve months of operation and submission of the Final Report herein supplied. Such report is in compliance with the Department of Energy's Special Terms and Conditions for Research Projects Grants for Climate Change Fuel Cell Program.

RESULTS AND CONCLUSIONS

COST BENEFIT ANALYSIS

The fuel cell at Cape Cod Community College provides the facility with a total of $189,319.49 per year in energy savings. This total is comprised of $4,096.00 in demand savings, $148,130.40 in kWh savings and $37,093.09 in heat recovery savings. The cost associated with running the fuel cell is $142,629.10 per year. This total includes $117,629.10 in gas usage costs as well as $25,000 in annual maintenance costs. The net annual savings to the EPA from the installation of the fuel cell is $46,690.38.

After netting the $200,000 DOE rebate out of the $600,000 capital cost of the fuel cell, the savings on this fuel cell provide a simple payback of just under 9 years for this investment.

ENVIRONMENTAL BENEFITS

Since fuel cells produce electricity through a chemical reaction, the amount of emissions is greatly reduced. CO2 emissions are minimal and Nox and SO2 emissions are eliminated. This was a great selling point to an environmentally conscious facility such as Cape Cod Community College.

CONCLUSION

As part of a successful energy conservation project at Cape Cod Community College, NORESCO installed a 200kW phosphoric acid PC25TM fuel cell power plant. In running nearly continuously since April of 1999, this fuel cell has provided a significant portion of the college's electrical demand. At the same time, it has also provided space heating for the adjacent library.

Cape Cod Community College has been very pleased with the success of this fuel cell application. The environmental impact of the reduced emissions is an additional benefit to both the college and the community in which they operate.

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